

FORM PTO-1390 (Modified) (REV 10-95)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER <b>HER0033</b>	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR <b>09/331554</b>	
INTERNATIONAL APPLICATION NO. <b>PCT/FR97/02399</b>		INTERNATIONAL FILING DATE <b>23 December 1997</b>		PRIORITY DATE CLAIMED <b>24 December 1996</b>	
TITLE OF INVENTION <b>ABSORBABLE COMPOSITION CONTAINING PROPIONIC BACTERIA CAPABLE OF RELEASING NITRIC OXIDE IN THE HUMAN OR ANIMAL ALIMENTARY CANAL</b>					
APPLICANT(S) FOR DO/EO/US <b>ROUSSEL, Edmond Daniel; LEGRAND, Charles Gabriel; LEGRAND Marc Henri; and ROLAND Nathalie</b>					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<ol style="list-style-type: none"> <li>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li>3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).</li> <li>4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</li> <li>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2)) <ol style="list-style-type: none"> <li>a. <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).</li> <li>b. <input type="checkbox"/> has been transmitted by the International Bureau.</li> <li>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li>6. <input type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</li> <li>7. <input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210).</li> <li>8. <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)) <ol style="list-style-type: none"> <li>a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</li> <li>b. <input type="checkbox"/> have been transmitted by the International Bureau.</li> <li>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</li> <li>d. <input type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li>9. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</li> <li>10. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).</li> <li>11. <input type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409).</li> <li>12. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).</li> </ol>					
Items 13 to 18 below concern document(s) or information included:					
<ol style="list-style-type: none"> <li>13. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</li> <li>14. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</li> <li>15. <input checked="" type="checkbox"/> A <b>FIRST</b> preliminary amendment. A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</li> <li>16. <input type="checkbox"/> A substitute specification.</li> <li>17. <input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li>18. <input checked="" type="checkbox"/> Certificate of Mailing by Express Mail</li> <li>19. <input checked="" type="checkbox"/> Other items or information:</li> </ol>					
Check No. <b>042043</b>					

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR		INTERNATIONAL APPLICATION NO. <b>PCT/FR97/02399</b>		ATTORNEY'S DOCKET NUMBER <b>HER0033</b>	
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20. The following fees are submitted:.

**BASIC NATIONAL FEE ( 37 CFR 1.492 (a) (1) - (5)) :**

<input type="checkbox"/> Search Report has been prepared by the EPO or JPO .....	<b>\$840.00</b>
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) .....	<b>\$670.00</b>
<input type="checkbox"/> No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) .....	<b>\$760.00</b>
<input checked="" type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO .....	<b>\$970.00</b>
<input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) .....	<b>\$96.00</b>

**ENTER APPROPRIATE BASIC FEE AMOUNT =**

Surcharge of **\$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	12 - 20 =	0	x \$18.00	<b>\$0.00</b>
Independent claims	2 - 3 =	0	x \$78.00	<b>\$0.00</b>
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				<b>\$0.00</b>
<b>TOTAL OF ABOVE CALCULATIONS =</b>				<b>\$970.00</b>
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable). <input type="checkbox"/>				<b>\$0.00</b>
<b>SUBTOTAL =</b>				<b>\$970.00</b>
Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				<b>\$0.00</b>
<b>TOTAL NATIONAL FEE =</b>				<b>\$970.00</b>
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				<b>\$0.00</b>
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☒ A check in the amount of **\$970.00** to cover the above fees is enclosed.

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**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

**SEND ALL CORRESPONDENCE TO:**

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**June 21, 1999**  
\_\_\_\_\_  
DATE

09/331554

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

510 Rec'd. PCTO 2 1 JUN 1999

In re the Application of  
Edmond Daniel Roussel et al.

Serial No.

Filed:

Title: ABSORBABLE COMPOSITION  
CONTAINING PROPIONIC BACTERIA  
CAPABLE OF RELEASING NITRIC OXIDE  
IN THE HUMAN OR ANIMAL  
ALIMENTARY CANAL

Group Art Unit:

Examiner:

**PRELIMINARY AMENDMENT DELETING  
MULTIPLE DEPENDENT CLAIM**

Assistant Commissioner of Patents  
Washington, DC 20231

Sir:

Prior to calculating the filing fee, please enter the following amendments to the application.

**IN THE CLAIMS**

In claim 12, line 1, delete "any one of claims 7 to 11" and substitute therefor --claim 7--.

Respectfully submitted,

Anthony Niewyk  
Registration No. 24, 871

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AN:pmp

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Date: June 21, 1999

WO 98/27991

PCT/FR97/02399

Absorbable composition containing propionibacteria  
which is capable of releasing nitric oxide into the  
human or animal digestive tract

The present invention relates to an absorbable  
5 common food composition or an absorbable dietary or  
medicinal composition containing propionibacteria which  
are capable of releasing physiologically significant  
amounts of nitric oxide into the human or animal  
digestive tract.

10 For many decades, it has been entirely ignored  
that nitric oxide is one of the elements necessary for  
life and for maintaining life; consequently, up until 4  
or 5 years ago, researchers paid little attention to  
the benefits associated with the presence of this  
15 oxide, either in medicine, in nutrition or in  
physiology.

It is only very recently that an impressive  
number of physiological functions have been attributed  
to nitric oxide and that the hypothesis was put forward  
20 that this gas might be involved extensively in  
functions as diverse as controlling arterial pressure,  
the non-specific cytotoxic function of macrophages,  
platelet aggregation and neurotransmission, or  
controlling the motility of the digestive tract.

25 Starting with this assumption, research related  
to nitric oxide mushroomed and the importance of this  
gas was able to be confirmed.

It is known that nitric oxide, which is a very  
unstable gas (half-life of less than 5 seconds in  
30 biological systems), is produced by biosynthesis in the  
human or animal body from L-arginine by a group of  
enzymes known as the NO-synthases (NOS), of which two  
main types exist, namely, on the one hand, the  
constituent NOSs which are expressed in particular in  
35 the endothelial cells, the blood platelets and the  
neurons, and, on the other hand, the inducible NOSs  
which are expressed mainly by certain cells of the  
immune system (macrophages and polymorphonuclear

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leukocytes in particular), by vascular smooth muscle and endothelial cells.

It should be noted that the production of NO by the inducible NOSs is greater than the production of NO by the constituent NOSs by several orders of magnitude, but that, in any case, this production remains relatively small.

Now, given the abovementioned beneficial role of nitric oxide, it would be desirable\* to be able to increase this production in particular by using the natural route of food metabolism.

However, no means for achieving this result have ever been proposed hitherto.

The object of the invention is to fill in this absence.

In accordance with the invention, it has been possible to achieve the desired aim by observing that, surprisingly, bacteria of one specific type, the propionibacteria, are capable of producing nitric oxide, and that, among these bacteria, certain species and certain strains among these species produce it in large amounts.

They are propionibacteria which, although not belonging to the group of lactic bacteria or bifidobacteria conventionally introduced into the body via milk-based desserts or other fermented dairy products, have nevertheless been present in human food for centuries: indeed, it is these bacteria which produce the holes during the manufacture of the cheese known as "emmental" which, after maturing, contains about  $10^9$  cells/g of propionibacteria.

It should be noted that the fermentation of these bacteria produces, inter alia, propionic acid, acetic acid and carbon dioxide.

The abovementioned finding is all the more surprising since it has been possible to confirm that lactic acid bacteria, bifidobacteria and/or yeasts, commonly used in the agrifood sector, do not produce carbon monoxide.

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These fractions can be ingested directly or prediluted in a liquid; they can be packaged in a form which facilitates absorption: tablets, sachets of granulated powder, liquid, etc.

It has been confirmed that such concentrated dehydrated preparations of propionibacteria stored for one year at +4°C undergo a fall in concentration of less than one Log unit.

5           Experience has shown that gelatin capsules, which may or may not be gastroresistant, are a particularly advantageous type of packaging.

          According to another characteristic of the invention, each individual fraction contains a large  
10   number of bacteria, preferably more than  $10^9$  bacteria.

          Various experiments (summarized below) confirmed the quite specific ability of different strains of propionibacteria to produce NO during their culturing, firstly indirectly by measuring the nitrite  
15   ions NO<sub>2</sub> [sic], and then directly by mass spectrometry analysis in anaerobic medium.

          During these experiments, the nitrite concentration in arginine-rich and nitrate-poor (50 µM) media was studied, in a first stage, and it was  
20   realized that arginine is not a determining factor in the observed production of NO.

          In a second stage, nitrate-supplemented media were investigated. The results obtained in the latter case revealed the nitrate-dependent nature of the  
25   production of nitric oxide.

#### 1 - Comparative preliminary tests

          Various bacterial strains (yoghurt inoculum, bifidobacteria, lactobacillus) were cultured in the  
30   presence of a reconstituted milk medium (100 ml) supplemented with a yeast extract (10 g/l) and then incubated at 37°C.

          The accumulation of nitrite was measured over time.

35           These preliminary tests were carried out under the following conditions:

- incubation at 37°C for 0, 4, 7 or 10 hours,
- 3 repetitions
- assay of the nitrites by the Bran-Luebbe system.

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In accordance with these tests, no accumulation of nitrite could be detected, either using yoghurt inoculum, bifidobacteria or *Lactobacillus*, irrespective of the incubation time (0, 4, 7 or 10 hours).



## 2 - Demonstration of the accumulation of nitrite by propionibacterium cultures

The possible presence of nitrate or nitrite in the preparation of the YEL medium was investigated beforehand by colorimetric assay (Boehringer kit): it was thus possible to demonstrate the presence of an appreciable amount of nitrate in this medium (concentration of about 50 to 100  $\mu\text{M}$ ) which might come from the yeast extract used for the manufacture of this medium; on the other hand, it was confirmed that the YEL medium was totally free of nitrite.

Propionibacterium cultures (1 g of lyophilisate per 100 ml of YEL medium) were tested.

These tests were carried out under the following conditions:

- incubation at 30°C for 24, 48 or 72 hours,
- 3 repetitions for the 24-hour incubation,
- stopping the incubation by boiling,
- purification of the product by centrifugation and passing the extract through C18 resin,
- assaying the nitrites in the medium by analysis on the Bran-Luebbe system.

The nitrites accumulated by the propionibacteria were assayed in order to establish kinetics of nitrite accumulation as a function of the incubation time of the bacteria on YEL medium.

Figure 3 represents, on the one hand, the variations in the amount of nitrite produced (in  $\mu\text{g}/100$  ml of culture) as a function of the incubation time (in hours) ( $\square$ ) and, on the other hand, the variations in the turbidity (absorbance at  $\lambda = 650$  nm) also as a function of the incubation time (O).

This figure shows that the amount of nitrite is at a maximum at 24 hours and then decreases significantly after 48 and 72 hours of incubation.

It may reasonably be considered that this fall results from the reduction of the nitrite to  $\text{NO}$ ,  $\text{N}_2\text{O}$  or other compounds by nitrite reductase.

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In accordance with the invention, it was possible to prove that the accumulation of  $\text{NO}_2$  depends on the propionibacterium species or strains used.

This situation was confirmed by the tests summarized below:

**3 - Demonstration and comparison of the nitrite accumulations in the culture medium in the case of 9 strains of 4 different propionibacterium-species**

10 In accordance with this test, the strains P20, P23, 2408, 2410, 2500 and 2501 of the species *P. freudenreichii* and the strains TL221, TL223 and TL207 belonging, respectively, to the species *P. thoenii*, *P. acidipropionici* and *P. jensenii*, were  
15 studied.

It should be noted that the TL (technologie laitière [dairy technology]) strains are strains belonging to the INRA-LRTL, while the strain P23 (or ITG23) was registered at the Collection Nationale des  
20 Cultures de Micro-organismes [National Collection of Microorganism Cultures] (CNCM) of the Institut Pasteur under the number I-1804 dated 18.12.96.

The various propionibacterium strains (1 g of lyophilisate or 5 ml of fresh culture) were cultured on  
25 100 ml of YEL medium containing about 50  $\mu\text{M}$  of nitrate, under the following conditions:

- incubation at 30°C for 12, 24, 36 or 48 hours,
- 3 repetitions,
- stopping the incubation by boiling,
- 30 • purification of the product by centrifugation and passing the extract through C18 resin,
- accumulation of nitrite in the medium, measured by analysis on the Bran-Luebbe system,
- estimation of the fermentation of each culture  
35 measured by reading the absorbance at 650 nm.

The results obtained for each strain are collated in Figure 4.

This represents, in each case, the variations in the accumulation of nitrite ( $\square$ ) and in the turbidity

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of the culture medium (O) as a function of the incubation time. Each value corresponds to the average  $\pm$  the standard error of mean for  $n = 3$ .

It should be noted that the scales of nitrite accumulation are 25 times greater in the case of the strains P23 and TL223.

These results prove that the bacterial growth, estimated from the change in turbidity of the culture medium, is similar for all of the strains studied, reaching about 2 to 2.5 OD after incubation for 48 hours, except for the strain TL221 for which the turbidity reaches only 0.6 OD after 2 days.

On the other hand, highly significant differences exist as regards the accumulation of nitrite as a function of time.

Specifically, the strains 2500, 2408, P20, 2501, 2410, TL207 and TL221 accumulate a relatively small amounts of nitrite, the maximum ( $0.1 \mu\text{g}$  of  $\text{NO}_2^-$  /ml) being reached after incubation for 36, 12, 36, 12, 12, 24 and 24 hours of incubation, respectively.

In contrast, a much greater accumulation of nitrite was obtained with strains P23 and TL223, which accumulate, at the maximum,  $1.8 \mu\text{g}$  of  $\text{NO}_2^-$  /ml after 36 and 24 hours of incubation, respectively.

It should be noted that the propionibacterium strain analyzed in the abovementioned second test (Figure 3) had an intermediate position with a maximum  $\text{NO}_2^-$  accumulation of about  $0.5 \mu\text{g}/\text{ml}$ .

These tests thus made it possible to state that significant differences exist between the amounts of nitrite which can be produced by different propionibacterium strains from four different species, these differences being independent of the growth of these strains.

These results could be confirmed by studying the change in the nitrite concentration of the culture medium as a function of its turbidity and thus, approximately, of the bacterial growth, for each strain.

The results of these last tests are given in Figure 5, in which each value corresponds to the average  $\pm$  standard error of mean for  $n = 3$ .

The abovementioned tests were designed to establish that, among the strains studied, the strain TL223 accumulates nitrites to the greatest extent, these nitrites disappearing after 12 hours. This strain was thus selected in the context of complementary tests relating to the direct measurement of the production of nitric oxide by mass spectrometry analysis in anaerobic medium.

#### 4 - Preliminary measurement of the production of NO by the strain TL223 under a helium atmosphere

In accordance with these tests, the cultures were prepared in 10 ml tubes containing 5 ml of YEL medium containing about 50  $\mu$ M of nitrate and 0.25 ml of fresh culture of the strain TL223.

The atmosphere of the tubes was immediately evacuated by a flow of helium (100 ml/min) for 100 seconds.

The accumulation of NO in the atmosphere of the tubes was then measured over time under the following conditions:

- incubation at 30°C for 24, 48 or 72 hours,
- 4 repetitions,
- measurement of the accumulation of NO by mass spectrometry analysis,
- estimation of the fermentation of each culture, measured by reading the absorbance at 650 nm.

During a preliminary test, the gas purification system (Roboprep G+) - mass spectrometer (Twenty-Twenty) was calibrated with increasing amounts of nitric oxide.

This gas was generated from  $\text{NaNO}_2$  in the presence of a solution of KI and  $\text{H}_2\text{SO}_4$ .

The identification and quantification of the nitric oxide were performed on the basis of its mass: 30 for  $^{14}\text{N}^{16}\text{O}$  and 31 for  $^{15}\text{N}^{16}\text{O}$  and  $^{14}\text{N}^{17}\text{O}$ . This

identification was then confirmed by measuring the isotope ratio:  $31/30 = [^{15}\text{N}^{16}\text{O} + ^{14}\text{N}^{17}\text{O}]/^{14}\text{N}^{16}\text{O}$ . It should be noted that the theoretical isotope ratio 31/30 for NO is 0.00367 in the absence of contamination with  $^{17}\text{O}$ .

5           The results of this preliminary test are given in Figure 6, in which the left-hand part (A) corresponds to the calibration curve of the mass spectrometer used to quantify the nitric oxide, while the right-hand part (B) corresponds to the measurement  
10   of the isotope ratio 31/30.

          The actual results of this test are given in Figure 7.

          More specifically, Figure 7A represents the variations in the accumulation of NO in the atmosphere  
15   of the tubes as a function of the turbidity of the medium, while Figure 7B represents the variations in this accumulation as a function of the incubation time.

          The vertical or horizontal bars indicate, when they are wider than the symbol, the standard error of  
20   mean for  $n = 4$ .

          A comparison of Figure 7B (which represents the change over time in the turbidity of the culture medium under helium) with Figure 4 (which represents this same change in air) shows that the growth of the strain  
25   TL223 is not significantly affected by an atmosphere consisting essentially of helium.

          It was also possible to establish that the rate of accumulation of nitric oxide in the atmosphere is constant over about the first 45 hours of incubation,  
30   and then curves off (Figure 7B), which corresponds to a turbidity close to 1.5 OD (Figure 7A).

          After incubation for about 65 hours (turbidity greater than 1.7 OD), about 1.5  $\mu\text{g}$  of NO are accumulated in the helium atmosphere per 1 ml of  
35   culture medium.

          The order of magnitude obtained is compatible with the nitrite contents measured in the medium of cultures in contact with air.

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In the latter case, it was in fact found (Figure 5) that the strain TL223 accumulated a maximum 1.8  $\mu\text{g}$  of  $\text{NO}_2^-/\text{ml}$  for a turbidity of 1.5 OD, which corresponds to about 1.2  $\mu\text{g}$  of  $\text{NO}/\text{ml}$ .

5 From this preliminary direct measurement of the production of  $\text{NO}$  by the strain TL223, an attempt was made, in accordance with the invention, to confirm the route of synthesis of this nitric oxide, and the notion of investigating whether or not this synthesis is  
10 stimulated by a supply of nitrite or nitrate was proposed for this purpose.

Such a stimulation was able to be confirmed by means of the tests summarized below:

15 **5 - Study of the stimulation of the production of  $\text{NO}$  by supplying nitrite or nitrate**

With the aim of investigating whether or not the production of  $\text{NO}$  by propionibacteria is possible from  $\text{NO}_2^-$  or  $\text{NO}_3^-$ , an investigation to see whether or  
20 not an increase in the production of  $\text{NO}$  by the strain TL223 when it is in the presence of 1 mM  $\text{KNO}_2$  or  $\text{KNO}_3$  (with and without isotopic labeling with  $^{15}\text{N}$ ) is observed was carried out.

This experiment was carried out under the  
25 following conditions:

- the strain TL223 was inoculated at a concentration of 1% in a YEL medium alone (control) or with addition of 1 mM  $\text{KNO}_2$ ,  $\text{KNO}_3$  or  $\text{K}^{15}\text{NO}_3$  with isotopic labeling with  $^{15}\text{N}$  (at a concentration of 50%),
- 30 • incubation at  $30^\circ\text{C}$  for 24, 48 and 72 hours,
- 3 repetitions per point and per treatment,
- accumulation of the  $\text{NO}$  and determination of the isotope ratio by mass spectrometry,
- estimation of the fermentation of each culture  
35 (turbidity) measured by reading the absorbance at 650 nm,
- assay of the nitrate and the nitrite after recovery of the bacterial media, centrifugation and measurement with a Boehringer kit.

The accumulation of NO as a function of the  $\text{NO}_3^-$  concentration (100, 150, 350, 650 and 1050  $\mu\text{M}$ ) or of the  $\text{NO}_2^-$  concentration (50, 100, 400, 800, 1000  $\mu\text{M}$ ) after incubation for 72 hours at 30°C (TL223 inoculated at a concentration of 1% in a YEL medium) was also analyzed.

The samples to be analyzed were distributed in NO analysis tubes whose atmosphere was immediately evacuated by flushing with helium for 150 s in order to obtain strict anaerobic conditions.

The effect of flushing with helium on a possible detection of NO by the mass spectrometer was tested on a sterile YEL medium: this YEL medium, preflushed with helium, was incubated at 30°C for 72 hours. After 0, 24, 48 and 72 hours of incubation (3 repetitions), no production of NO was detected and the turbidity values remained at 0.

It was thus possible to check the quality of the helium flush, the absence of any bacterial contamination and the absence of interaction between the helium flush and the measurement of NO by mass spectrometry.

The abovementioned tests gave the results reported in Figure 8, as regards the kinetics of accumulation of NO in the presence of nitrite or nitrate.

More specifically:

- Figure 8A represents the variations in the accumulation of NO as a function of time,
- Figure 8B represents the variations in the turbidity as a function of time,
- Figure 8C represents the variations in the isotope ratio [mass 31/(masses 30+31)] as a function of time,
- Figure 8D represents the variations in the production of NO as a function of the turbidity.

Each of these figures relates to the strain TL223 cultured on a YEL medium alone, in the presence of 1 mM nitrate ( $^{15}\text{NO}_3^-$  - labeled to a proportion of 50% and  $^{14}\text{NO}_3^-$ ) and in the presence of 1 mM nitrite.

These figures prove that the accumulation of NO  
5 by TL223 cultured on 1 mM KNO<sub>3</sub> (labeled with  
nitrogen-15 or unlabeled) or on 1 mM KNO<sub>2</sub> is close to  
7 µg of NO/ml after incubation for 48 hours at 30°C;  
this value is 3.5 times greater than the production of  
NO in the case of a YEL medium not supplemented with  
10 nitrate or nitrite (Figure 8A). These differences are  
not due to growth variations generated by the  
composition of the medium, since the turbidity at the  
end of growth is of the same order of magnitude on a  
YEL medium alone (4.5 OD units after 72 hours) and on  
15 the same medium supplemented with nitrate or nitrite  
(about 5 OD units after 72 hours - Figures 8B and 8D).

It was also observed that when the strain TL223 is cultured on  $K^{15}NO_3$ , the profile of the peak of mass 31 ( $^{15}N^{16}O$ ) increases to a great extent relative to the NO analyzed on a YEL medium containing unlabeled nitrate, thereby confirming this situation.

These last observations very clearly confirm that the gas analyzed by mass spectrometry was indeed NO.

These tests thus made it possible to state that the strain TL223 is capable of synthesizing NO directly from nitrite or in the presence of nitrate after reducing this nitrate to nitrite.



On the basis of the isotope ratio values obtained on YEL medium supplemented with 1 mM  $K^{15}NO_3$  labeled to a proportion of 50%, it is possible to deduce the degree of conversion of nitrate into nitrite: thus, about 20% of the  $K^{15}NO_3$  supplied is converted into nitric oxide by the strain TL223.

The nitrate, initially present in the sterile YEL medium, explains the observed NO production by TL223 (of about 2  $\mu g$  of NO/ml after incubation for 72 hours - Figure 7).

The variations in NO production as a function of the nitrite or nitrate concentration are represented in Figure 9. More specifically:

- Figure 9A represents the variations in NO production and the change in the turbidity as a function of the initial nitrate concentration, by the strain TL223 cultured on YEL medium after incubation for 72 hours,
- Figure 9B represents the variations in NO production and the change in the turbidity as a function of the initial nitrite concentration, by the strain TL223 cultured on YEL medium after incubation for 72 hours,
- Figure 9C represents the variations in the degree of conversion of nitrate into NO, as a function of the initial nitrate concentration,
- Figure 9D represents the variations in the degree of conversion of nitrite into NO, as a function of the initial nitrite concentration.

In these figures, the nitrate concentrations have been corrected taking into account the presence of about 50  $\mu M$  nitrate in the YEL medium alone, and are as follows: 100, 150, 350, 550, 650 and 1050  $\mu M$ .

The nitrite concentrations are as follows: 50, 100, 400, 800 and 1000  $\mu M$ .

These figures show that, for the ranges chosen, the production of nitric oxide by the strain TL223 is proportional to the initial concentration of nitrate

(Figure 9A) or of nitrite (Figure 9B) in the YEL medium. This relationship is linear.

In both cases, no plateau phase was observed, which leads to the assumption that the nitrate or nitrite concentrations used do not make it possible to obtain the maximum level of accumulation of NO by the propionibacterium TL223.

It should also be noted that the presence of high concentrations of nitrate or nitrite do not affect the bacterial growth, given that the turbidity values at 72 hours are very similar for all the concentrations which were tested.

It should moreover be pointed out that the curves obtained in Figures 9A and 9B can be superimposed, which proves that the NO produced comes directly from the nitrite or nitrate via reduction of the latter to nitrite.

Furthermore, these results show that, with the strain TL223, the step of reduction of nitrate to nitrite is not limiting for the nitrate concentrations chosen in this experiment.

It is also important to point out that the degree of conversion of the  $\text{NO}_3^-$  (Figure 9C) and of the  $\text{NO}_2^-$  (Figure 9D) changes as a function of the amount of substrate available, passing from 20 to 60% when the  $\text{NO}_3^-$  or  $\text{NO}_2^-$  concentration passes from 1000 to 100  $\mu\text{M}$ .

This suggests that the production of NO is strongly regulated and that it is predominant over the use of nitric nitrogen for the nitrogenous syntheses.

From the abovementioned conclusions, the production of NO was studied in 12 strains of propionibacteria of two different species. The results of these tests are summarized below:

#### 6 - Study of the production of NO by different propionibacterium strains

In accordance with this test, the propionibacterium strains selected were the following:

*P. freudenreichii* : LS410, LS2501, LS2502, ITG 23,  
CNRZ89, CNRZ277, CNRZ81.

*P. acidipropionici* : TL223, NCD01072, PR75, CNRZ80,  
CNRZ86, CNRZ287.

5           It should be noted that the strains CNRZ80,  
CNRZ81, CNRZ86, CNRZ89, CNRZ277 and CNRZ287 belong to  
the INRA-CNRZ public collection, while the strain  
NCD01072 belongs to the British collection "National  
Collection of Dairy Organisms"; the other strains  
10 belong to private collections.

After inoculation on YEL medium in the presence  
of 550  $\mu$ M nitrate, the bacterial cultures were  
immediately distributed in 5 ml units in sealed tubes  
and flushed with helium (anaerobic conditions). Next,  
15 the propionibacterium strains were subjected to the  
following experimental conditions:

- incubation at 30°C for 24, 48 and 72 hours,
- 3 repetitions,
- accumulation of NO in the atmosphere and  
20 determination of the isotope ratio by mass  
spectrometry,
- estimation of the fermentation of each culture,  
measured by reading the absorbance at 650 nm,
- assay of the nitrate and nitrite after recovering the  
25 bacterial media, centrifugation and measurement with  
a Boehringer kit.

Figure 10 represents the variations in the  
accumulation of NO as a function of time by the strain  
TL223 and the 12 other propionibacterium strains,  
30 cultured on a YEL medium in the presence of 550  $\mu$ M  
nitrate. The strain TL223 was represented in each case  
for comparative purposes.

The vertical bars represent the  $\pm$  standard  
error of mean for  $n = 3$  when they are larger than the  
35 symbol.

This figure shows the existence of large  
divergence between the propionibacterium strains.

Globally, by comparing the levels of production of NO after incubation for 72 hours, the strains can be classified in three categories:

- strains capable of producing from 4 to 4.5  $\mu\text{g}$  of NO/ml: TL223, CNRZ80, NCDO1072 and PR75. The isotope ratio for the NO produced by these strains is between 2 and 2.5% (T = 72 h),
- strains capable of producing about 2  $\mu\text{g}$  of NO/ml: CNRZ81, CNRZ86, CNRZ89, CNRZ277, LS2502 and ITG23. The isotope ratio for the NO produced by these strains is between 4 and 5.5% (T = 72 h),
- strains producing less than 1  $\mu\text{g}$  of NO/ml: LS410, LS2501 and CNRZ287. Despite the presence of 550  $\mu\text{M}$  nitrate in the culture medium, these 3 strains produced only very small amounts of NO and the isotope ratio was about 10 to 13% (T = 72 h). These values suggest that the peaks of masses 30 and 31 detected in these bacteria might not correspond to nitric oxide.

It should be noted that, in the strains belonging to the first two categories, the NO produced does not decrease at the end of growth and that it therefore does not appear to be reused by the propionibacteria: there is thus accumulation of NO.

Figure 11 represents the variations in NO production as a function of the turbidity for the 13 abovementioned propionibacterium strains, cultured on YEL medium in the presence of 550  $\mu\text{M}$  nitrate. The strain TL223 was represented in each case for comparative purposes.

The vertical bars represent the  $\pm$  standard error of mean for  $n = 3$ , when they are larger than the symbol.

Figure 12 represents the variations in the turbidity (OD at 650 nm) as a function of time for the 13 strains of propionibacterium analyzed, cultured on YEL medium in the presence of 550  $\mu\text{M}$  nitrate.

The strain TL223 is represented in each case for comparative purposes.

The vertical bars represent the standard error of mean for  $n = 3$ , when they are larger than the symbol.

The strains which produce the most NO (TL223, CNRZ80, NCDO1072 and PR75) all reach high turbidity values (4 to 5 OD units after incubation for 72 hours).

Among these strains, it should be noted that the bacteria NCDO1072 and PR75 grow less quickly than TL223, but are capable of accumulating large concentrations of NO very rapidly.

Thus, PR75 produces 2.8  $\mu\text{g}$  of NO/ml for a turbidity of 0.5 OD units. The maximum NO production is recorded for turbidity values of about 1.5 OD units for NCDO1072 and PR75, compared with 3.4 OD units for TL223.

In order to "refine" these results, the change in the NO, nitrate and nitrite concentrations of the culture media for the 13 strains of propionibacterium studied, as a function of the incubation time was analyzed.

The results obtained are collated in the table below, in which the concentrations are expressed in  $\mu\text{M}$ . For each strain, the measurements were taken on a tube, after removal of the bacteria by centrifugation.

	P. freudenreichii			P. acidipropionici			P. thymotrophicum		
	0h	24h	48h	0h	24h	48h	0h	24h	48h
LS410	674	638	596	0	5	22	13	18	23
LS2501	645	649	406	6	13	215	12	26	35
LS2502	338	0	0	176	122	16	12	53	72
ITG23	441	218	24	11	246	278	10	36	62
CNRZ89	595	160	42	16	171	154	10	38	74
CNRZ277	559	435	246	17	3	85	12	42	66
CNRZ81	0	0	0	400	12	0	26	66	71
P. acidipropionici									
TL223	0	0	0	271	0	0	71	149	152
NCDO1072	0	2	0	370	3	0	50	148	146
PR75	11	2	0	185	1	0	91	147	146
CNRZ80	0	0	0	146	0	0	93	136	140
CNRZ86	594	491	0	14	41	405	9	28	62
CNRZ287	624	570	646	0	0	5	9	20	29

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This table allows the following observations to be made:

- the strains producing 4  $\mu\text{g}$  of  $\text{NO}/\text{ml}$  are capable of entirely reducing the available nitrate (i.e. 550  $\mu\text{M}$ ) after 24 hours of incubation. Furthermore, they can totally reduce the nitrite obtained during the first 48 hours of incubation,
- the strains LS410 and CNRZ287, which produce very low levels of  $\text{NO}$ , are not capable of significantly absorbing the nitrate present in the medium,
- for the strains which display an intermediate accumulation of  $\text{NO}$ , very different changes in the nitrate and nitrite concentrations can be observed, reflecting very different rates of absorption of  $\text{NO}_3^-$  and/or of reduction of  $\text{NO}_3^-$  and of  $\text{NO}_2^-$ . Thus, the strain CNRZ81 is capable of reducing all of the nitrate after 24 hours of incubation. After 48 hours, CNRZ81 also reduces all of the  $\text{NO}_2^-$  obtained by reduction of the  $\text{NO}_3^-$ . In contrast, CNRZ277 still contains 246  $\mu\text{M}$   $\text{NO}_3^-$  and 85  $\mu\text{M}$   $\text{NO}_2^-$  after 72 hours of incubation.

The tests summarized above revealed that certain propionibacterium strains are capable of reducing the nitrate in the culture medium and thus producing the nitrite required for the synthesis of  $\text{NO}$ .

- It should be noted that the propionibacterium strains which produce the most  $\text{NO}$  (TL223, CNRZ80, NCDO1072 and PR75) all belong to the species *P. acidipropionici* and, moreover, all have nitrate reductase activity.

- In contrast, the strains apparently producing less  $\text{NO}$ , or even none at all (detection limit of the mass spectrometer) are also bacteria which have no known nitrate reductase activity (LS410, LS2501 and CNRZ287).

- For certain propionibacterium strains, it appears that the  $\text{NO}$  production kinetics are not directly linked to the nitrate reductase activity.

Given these results, the invention also relates to an absorbable dietary or medicinal composition,

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5

10

be particularly advantageous.

15

20

25

30

below:

## 35

lactic acid bacteria results in different N-containing

products" Gudrun Wolf, Elke K. Arendt, Ute Pfähler and  
Walter P. Hammes - International Journal of Food  
Microbiology, 10 (1990) 323-330) which mentions that  
certain lactic acid bacteria (*L. farciminis*) are  
5 capable of producing nitric oxide from nitrite.

Preliminary experiments showed that after  
growing the strain *L. farciminis* for 5 h 30 min in MRS  
supplemented with 1 mM nitrate, nitrate and nitrite  
were no longer detected in the culture medium.

10 The same observation was made as regards the  
strain *E. coli* after growth for 7 h 30 min on BHI  
medium supplemented with 1 mM nitrate.

It is known that, during its growth, the strain  
*L. farciminis* acidifies the MRS medium (about pH 5  
15 after culturing for 5-6 hours).

It was possible to observe, from tests carried  
out on YEL medium, that nitrites are converted into NO  
in acidic medium.

These tests were carried out under the  
20 following experimental conditions:

- acidification of the YEL medium with HCl,
- nitrite supplied at a concentration of 400 µM,
- autoclaving of the media,
- three repetitions.

25 The results obtained are collated in Figure 13  
which represents the variations, as a function of the  
pH, in the production of NO in the YEL medium  
supplemented with nitrites after incubation at 37°C for  
24 hours.

30 This figure is able to prove that there is  
appreciable production of NO from the nitrite in the  
medium when this medium is acidic, this production  
increasing as the pH decreases.

Consequently, comparative tests of NO  
35 production by *L. farciminis* and by *E. coli* which is  
reputed not to produce NO (Brittain T, Blackmore R,  
Greenwood C & Thomson AJ (1992) - Bacterial nitrite -  
reducing enzymes - Eur. J. Bio. Chem., 209, 793-802),  
were carried out.

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These tests were carried out under the following conditions:

- incubation at 37°C on BHI medium (*E. coli*) or MRS medium (*L. farciminis*),
- 5 - nitrate supplied to the medium at a concentration of 1 mM,
- flushing of the atmosphere of each tube with helium for 100 seconds,
- three repetitions,
- 10 - measurement of the turbidity at the end of incubation.

These tests gave the results reported in Figure 14.

More specifically:

- 15 - Figure 14A represents the variations in NO production as a function of the incubation time,
- Figure 14B represents the variations in NO production as a function of the turbidity of the medium.

20 It should be noted that the values obtained for the NO production are all markedly lower than the threshold of 1 µg/ml which was considered above as significant: the result of this is that there is no accumulation of NO in the culture tubes.

25 These results thus indicate that the absence of nitrate and nitrite observed in the preliminary experiment after 5 h 30 min (*L. farciminis*) and 7 h 30 min (*E. coli*), respectively, is not compensated for by an accumulation of NO which might be either of  
30 chemical origin (associated with acidification of the medium) or of bacterial origin.

In the case of the *L. farciminis* strain, these results were confirmed by tests carried out on bacteria in the form of resting cells at a pH adjusted to 6.5 by  
35 a phosphate buffer containing lactate, under the following operating conditions:

- incubation at 37°C,
- nitrate supplied at a concentration of 400 µM,

- flushing of the atmosphere of each tube with helium for 100 seconds
- three repetitions,
- measurement of the turbidity at the end of incubation.

This analysis gave the results reported in Figure 15:

- Figure 15A represents the variations in NO production as a function of the incubation time,
- Figure 15B represents the variations in NO production as a function of the turbidity.

These results confirm those obtained above, i.e. that the amounts of NO produced are too small to be significant and thus that the *L. farciminis* strain is not capable of accumulating nitric oxide. However, it is possible that this strain produces nitric oxide at the start of growth, but that any NO produced is reused by the bacterium.

Complementary tests were carried out on the strains TL223 and CNRZ80 in the form of resting cells after incubation at 30 and also at 37°C.

#### **8 - Change in NO production by propionibacteria in the form of resting cells**

This experiment was carried out under the following conditions:

- resting cells suspended in a phosphate buffer containing lactate, at pH 6.5,
- incubation at 30°C or at 37°C,
- nitrite supplied at a concentration of 400 µM,
- flushing of the atmosphere of each tube with helium for 100 seconds,
- three repetitions,
- measurement of the turbidity at the end of incubation.

It should be noted that, during the tests relating to the incubation at 30°C, in addition to the strains TL223 and CNRZ80, the strain CNRZ81 was examined with a twofold bacterial concentration.

This experiment gave the results reported in Figures 16 and 17. More specifically:

- Figure 16A represents the variations in NO production by resting cells at 30°C as a function of the incubation time,
- Figure 16B represents the variations in NO production by resting cells at 30°C as a function of the turbidity of the medium,
- Figure 17A represents the variations in NO production by resting cells at 37°C as a function of the incubation time,
- Figure 17B represents the variations in NO production by resting cells at 37°C as a function of the turbidity of the medium.

These results are able to prove that there is a consequent production of NO by resting cells not only in the case of the two strains of the species *P. acidipropionici* (TL223 and CNRZ80), but also in the case of the strain of the species *P. freudenreichii* (CNRZ81). The strain TL223 is the most productive.

Globally, for identical bacterial concentrations, the NO production by resting cells is of the same order as that observed in the case of bacteria cultured on YEL medium.

The production of NO by resting cells occurs essentially during the first five hours of incubation; beyond this period, the production is low.

It was thus possible to observe that, at 37°C, the production of NO is identical (TL223) or slightly higher (CNRZ80) than that obtained at 30°C.

The advantages associated with the ingestion of propionibacteria were, in addition, confirmed by investigations performed in vivo on healthy humans.

9 - Study of the effect of ingestion of propionibacteria on intestinal transit in healthy humans

5 This study was carried out in a hospital environment at the University Hospital of Caen on a series of 19 healthy male volunteers.

At the start of this test, each volunteer was given 10 radio-opaque markers to absorb, for 8 consecutive days, in accordance with the procedure described in the publications Arhan P, Devroede G, Jehannin B et al. *Dis Colon Rectum* 1981; 24:625-9 and Bouchoucha M, Devroede G. Arhan P et al. *Dis Colon Rectum* 1992; 35:773-82.

15 According to this procedure, study of the transit is carried out by counting the radio-opaque markers ingested in the different areas of the abdominal cavity, which are distributed on an anterior abdominal image. These areas (right colon, left colon and rectosigmoid) are defined by imaginary lines joining the 5th lumbar vertebra to the contour of the pelvic cavity. The transit time is calculated according to the formula  $T = 1/N \cdot n - At$ ; N being equal to 10 markers, n representing the number of markers counted in a region and At being equal to 24 hours.

25 The day after this ingestion, i.e. the 9th day, the volunteers were made to undergo a radiography of the anterior abdomen without preparation.

Starting from the following day, i.e. the 10th day, each volunteer was given a gelatin capsule to ingest daily for 2 weeks, this capsule containing  $5 \times 10^{10}$  propionibacteria obtained from a bank of strains used in the cheesemaking industry, and thus entirely harmless to man.

35 A second study of the transit time similar to the first study was carried out during the second week of ingestion of the propionibacteria, i.e. from the 17th to the 26th day.

This study revealed a significant deceleration in the transit time of the left colon ( $p < 0.05$  in

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CLAIMS

1. Use of propionibacteria to produce an absorbable common food composition or an absorbable dietary or medicinal composition which is capable of releasing physiologically significant amounts of nitric oxide into the human or animal digestive tract.
2. Use according to Claim 1, characterized in that the composition consists of a dehydrated preparation.
3. Use according to Claim 2, characterized in that the composition is in the form of individual fractions containing the dose of bacteria which needs to be regularly absorbed.
4. Use according to Claim 3, characterized in that each individual fraction contains more than  $10^9$  bacteria.
5. Use according to Claim 1, characterized in that the composition consists of a fermented or unfermented liquid preparation.
6. Use according to Claim 1, characterized in that the composition is an elaborate preparation, the propionibacteria being added or incorporated into foods such as cheeses or dietary fiber.
7. Absorbable dietary or medicinal composition, characterized in that it consists of a preparation containing a large amount, preferably more than  $10^9$  cells/g, of strains of propionibacteria selected as a function of their ability to release and/or to accumulate nitric oxide, in a proportion of at least 1  $\mu\text{g/ml}$  of YEL medium containing 550  $\mu\text{M}$  nitrate.
8. Composition according to Claim 7, characterized in that it contains propionibacteria belonging to at least one of the strains TL223, CNRZ80, CNRZ86 and NCDO1072 of the species *P. acidipropionici*.
9. Composition according to Claim 8, characterized in that it contains propionibacteria belonging to the strain TL223 of the species *P. acidipropionici*.

- [illegible]

APPLICANT OR PATENTEE: Edmond D. Roussel Attorney's Docket No.: HER0033

SERIAL NO. OR PATENT NO. 09/331,554

FILED OR ISSUED: \_\_\_\_\_

TITLE: ABSORBABLE COMPOSITION CONTAINING PROPIONIC BACTERIA CAPABLE OF RELEASING NITRIC OXIDE IN THE HUMAN OR ANIMAL ALIMENTARY CANAL

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS  
((37 CFR 1.9(f) and 1.27(c)) - SMALL BUSINESS CONCERN**

I hereby declare that I am:

☐ the owner of the small business concern identified below:

☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: \_\_\_\_\_

ADDRESS OF CONCERN: \_\_\_\_\_

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention entitled:

ABSORBABLE COMPOSITION CONTAINING PROPIONIC BACTERIA CAPABLE OF RELEASING NITRIC OXIDE IN THE HUMAN OR ANIMAL ALIMENTARY CANAL  
by inventor(s) Edmond Daniel Roussel et al.

described in:

☐ the specification filed herewith.

☒ Application Serial No. 09/331,554, filed June 21, 1999.

☐ Patent No. \_\_\_\_\_, issued \_\_\_\_\_.

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below\* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by an concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e). \*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27).

FULL NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

☐ INDIVIDUAL

☐ SMALL BUSINESS CONCERN

☐ NON PROFIT ORGANIZATION

FULL NAME: \_\_\_\_\_

ADDRESS: \_\_\_\_\_

☐ INDIVIDUAL

☐ SMALL BUSINESS CONCERN

☐ NON PROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate (37 CFR 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING: Charles LEGRAND

*Charles G. Legrand*

TITLE OF PERSON OTHER THAN OWNER: Director

ADDRESS OF PERSON SIGNING: Les Ombrages N° 3, 14 Avenue de Creully

14000 Caen France

SIGNATURE: \_\_\_\_\_

DATE: July 20, 1999

*CH. G. LEGRAND*  
CH. G. LEGRAND



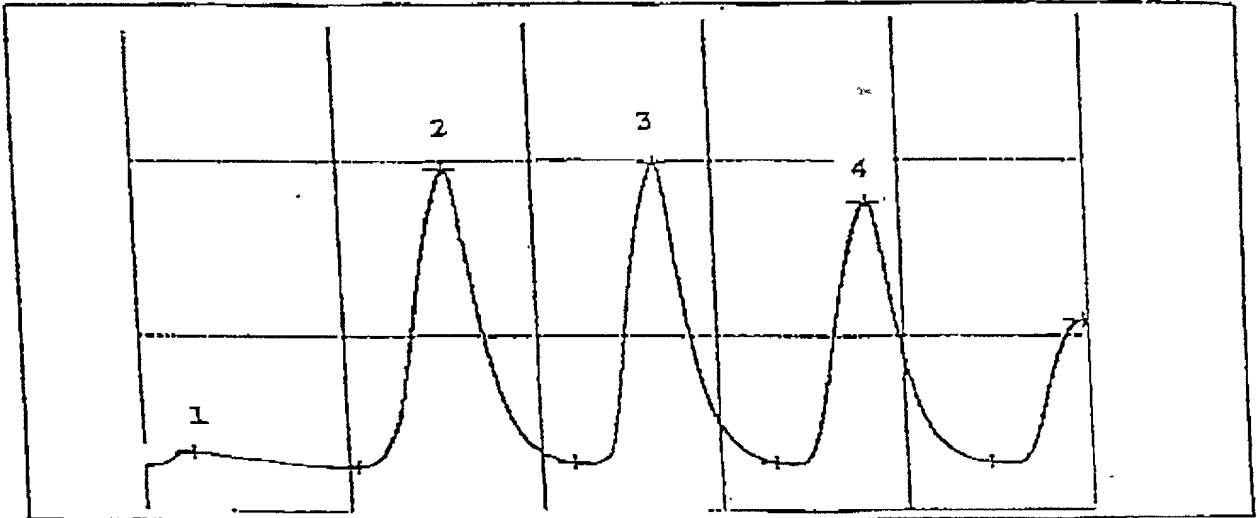


Figure 1

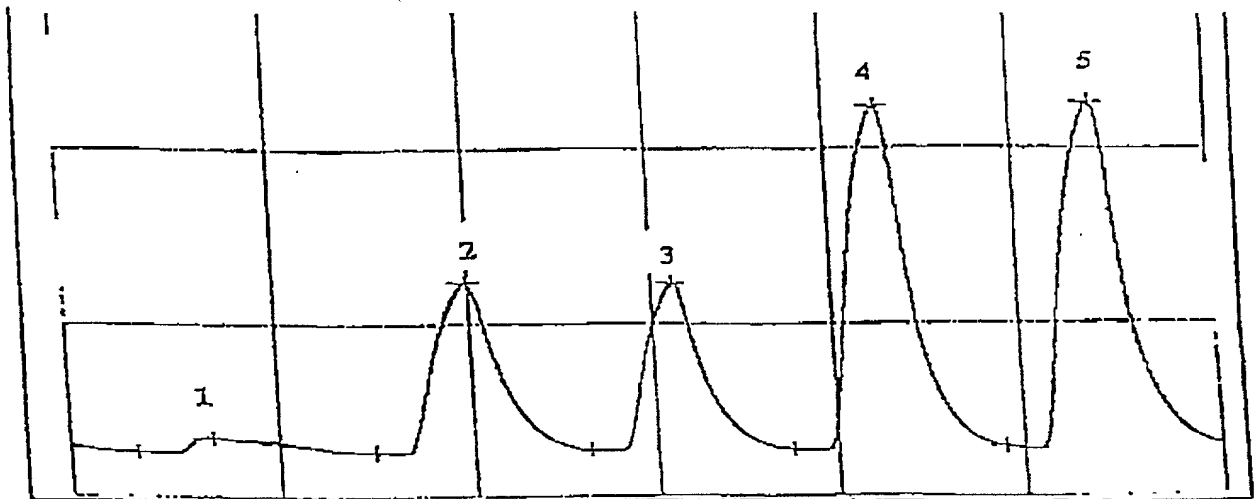


Figure 2

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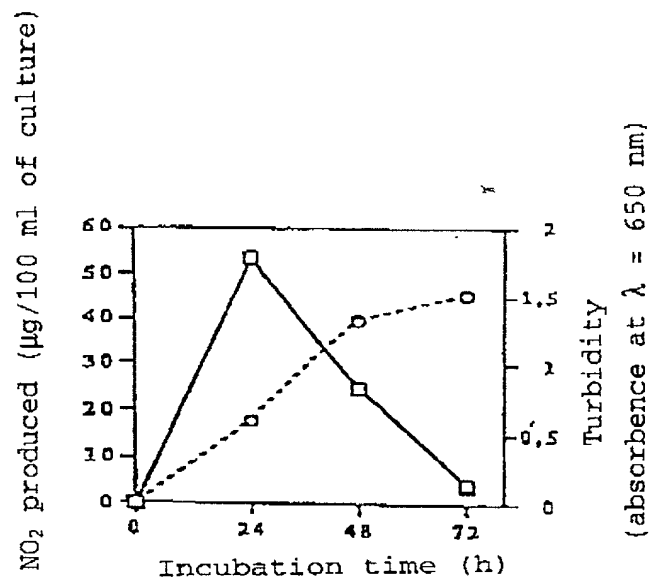


Figure 3

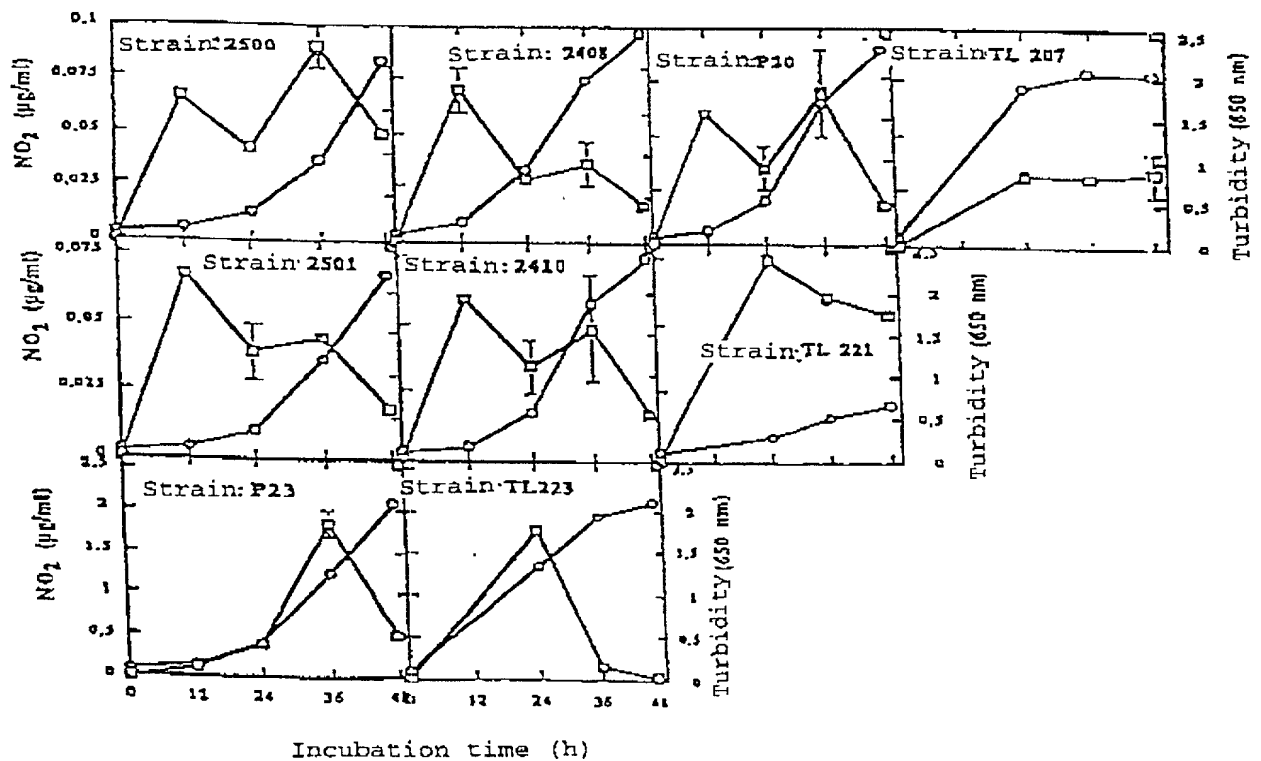


Figure 4

REPLACEMENT SHEET (RULE 26)

09/331554-02399

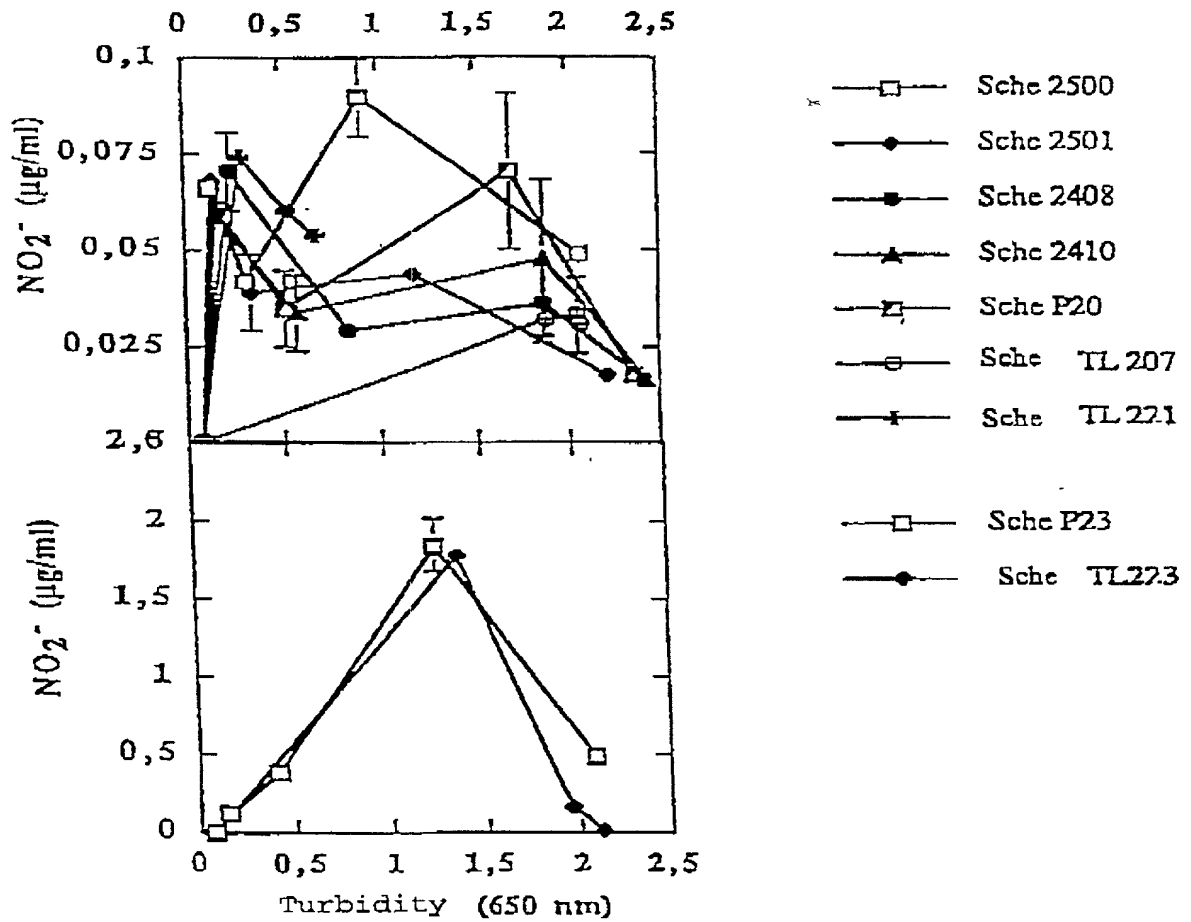


Figure 5

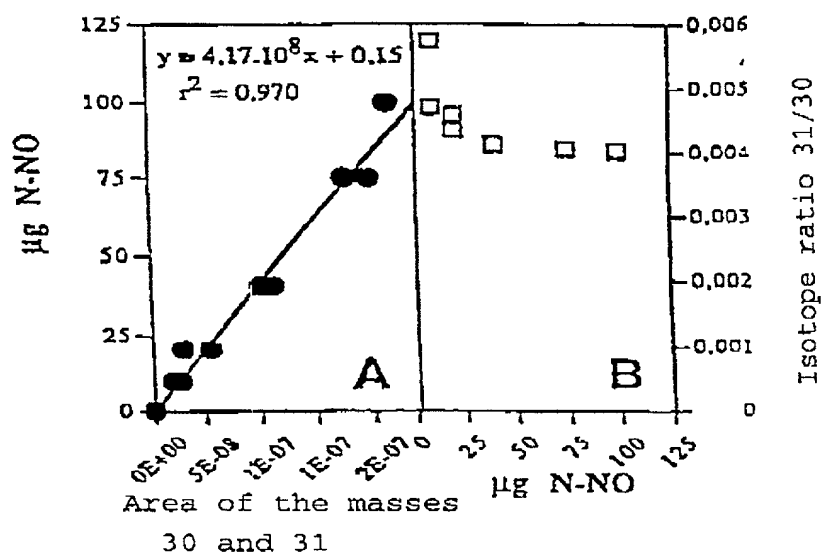


Figure 6

5/12

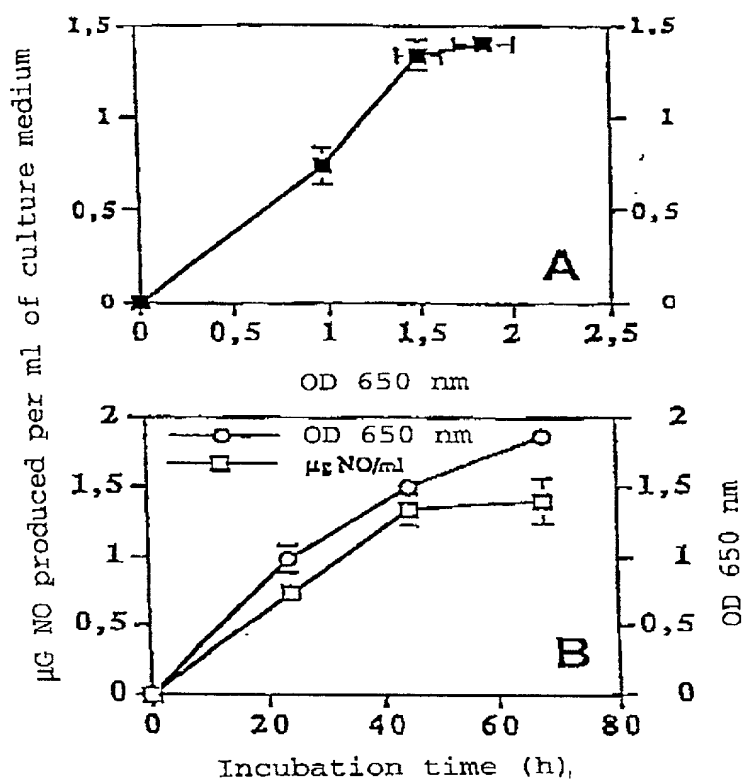


Figure 7

6/12

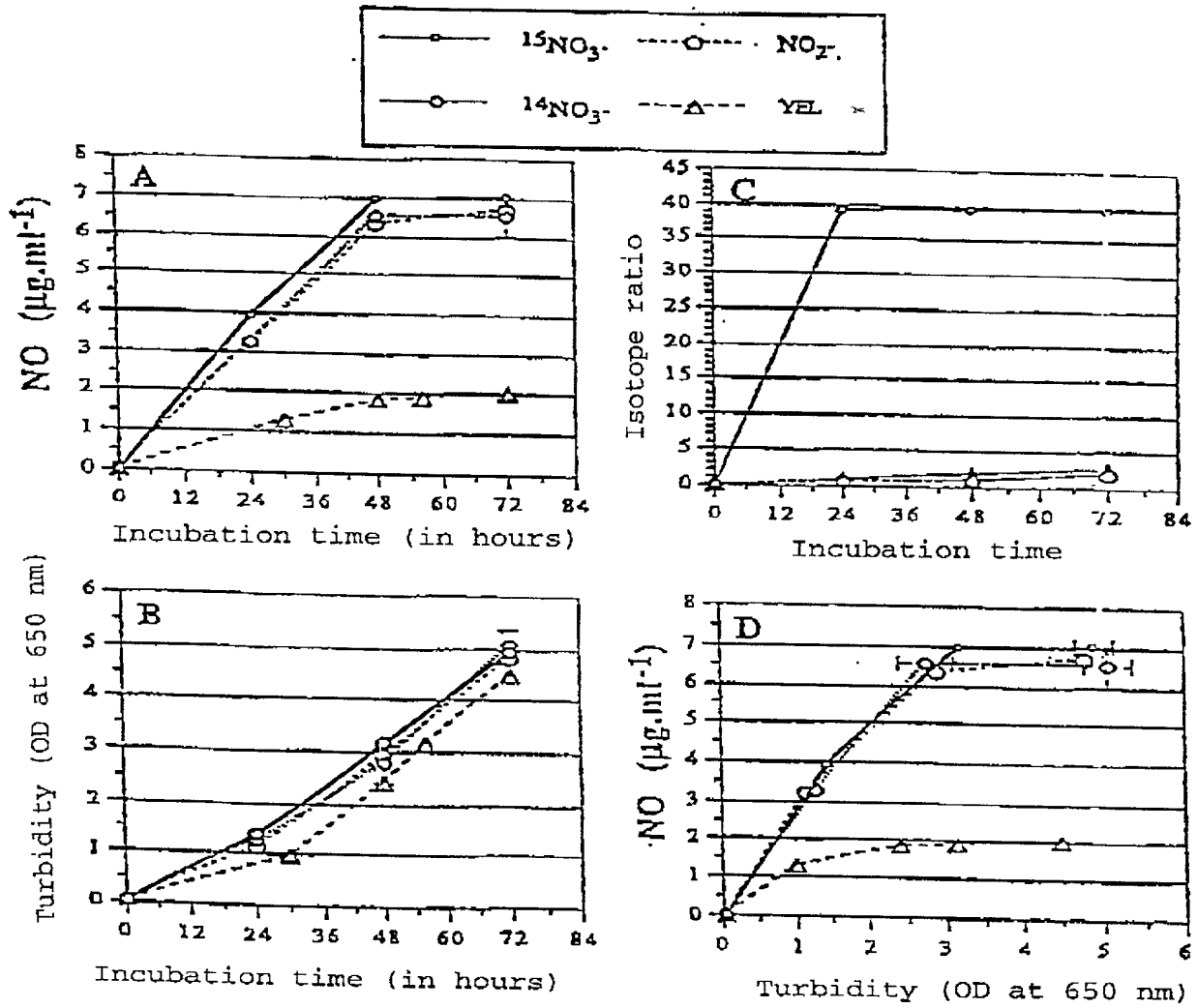


Figure 8

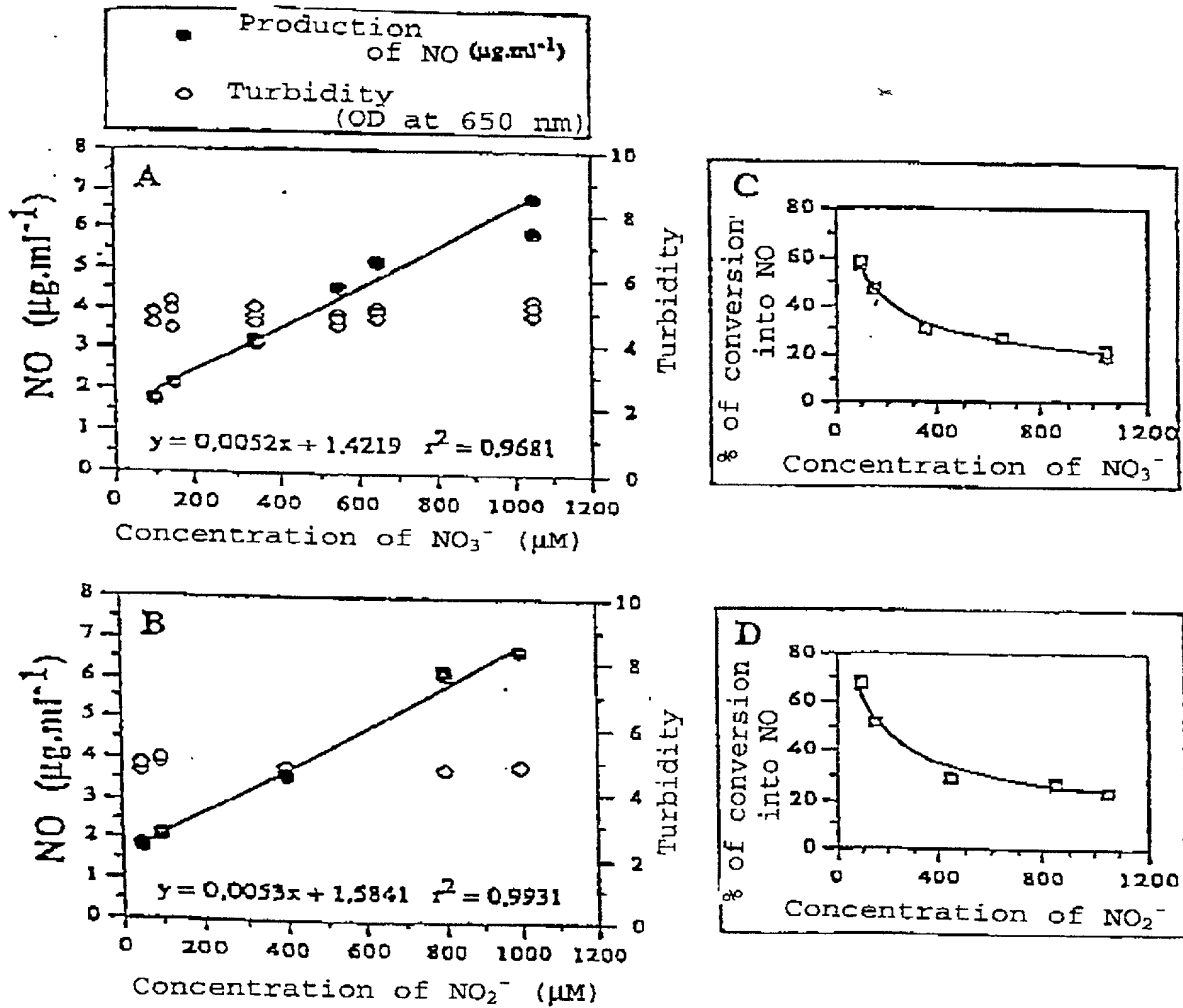


Figure 9

8/12

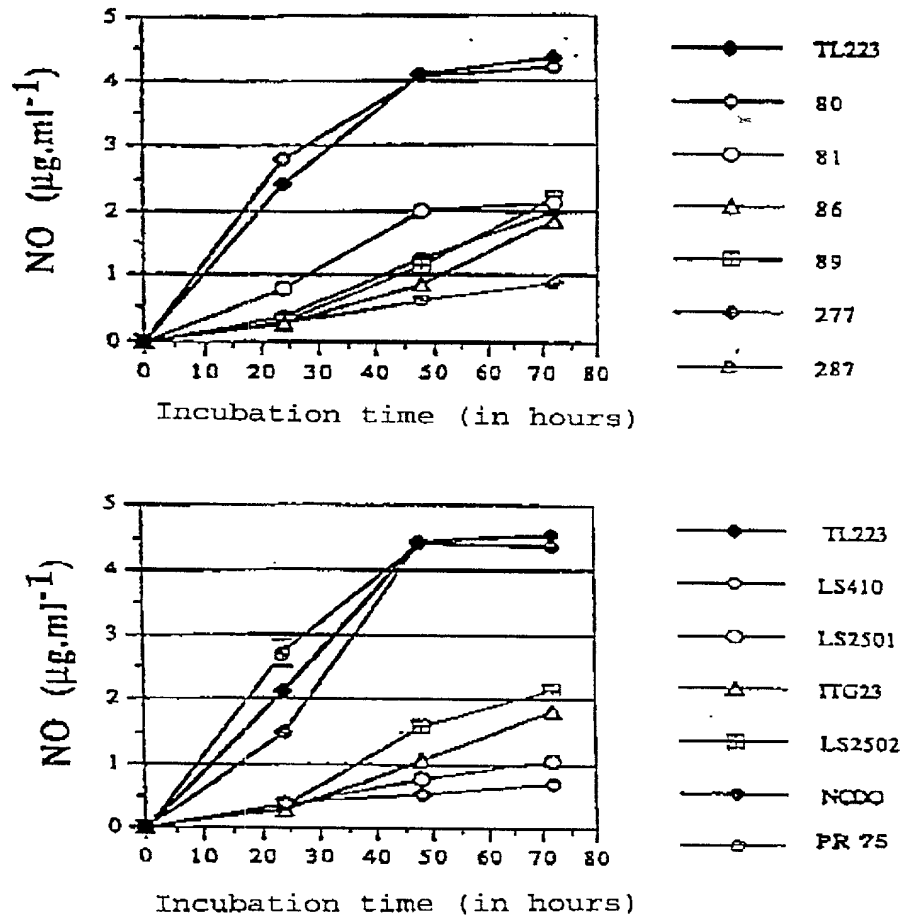


Figure 10



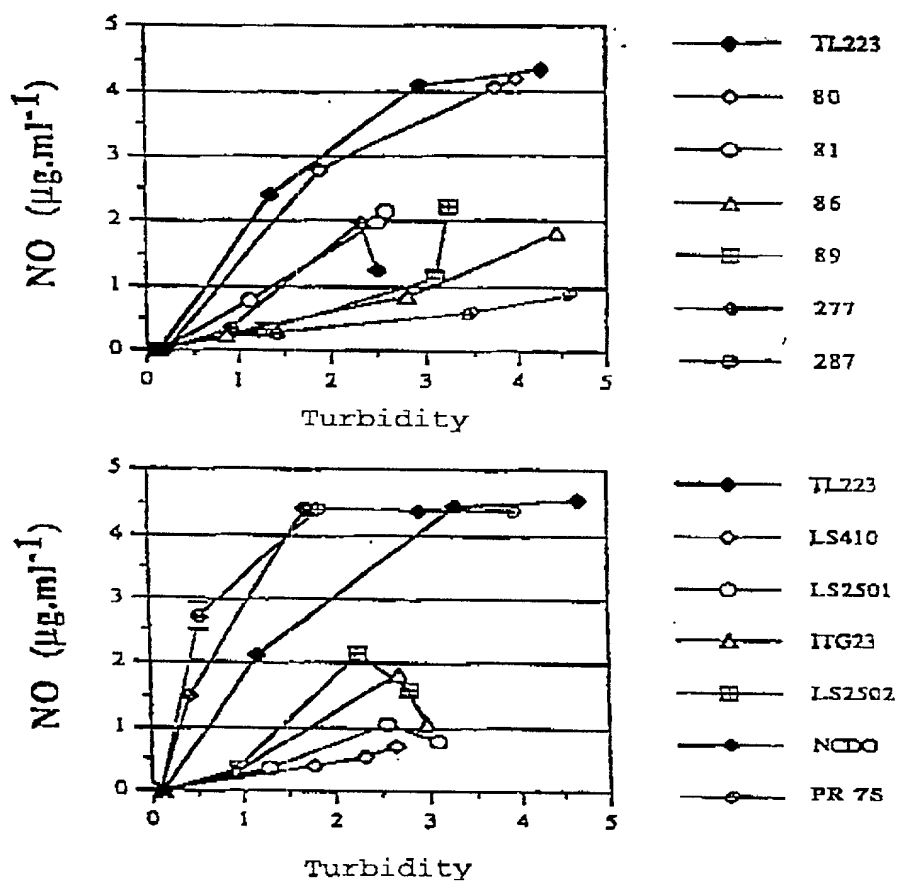


Figure 11

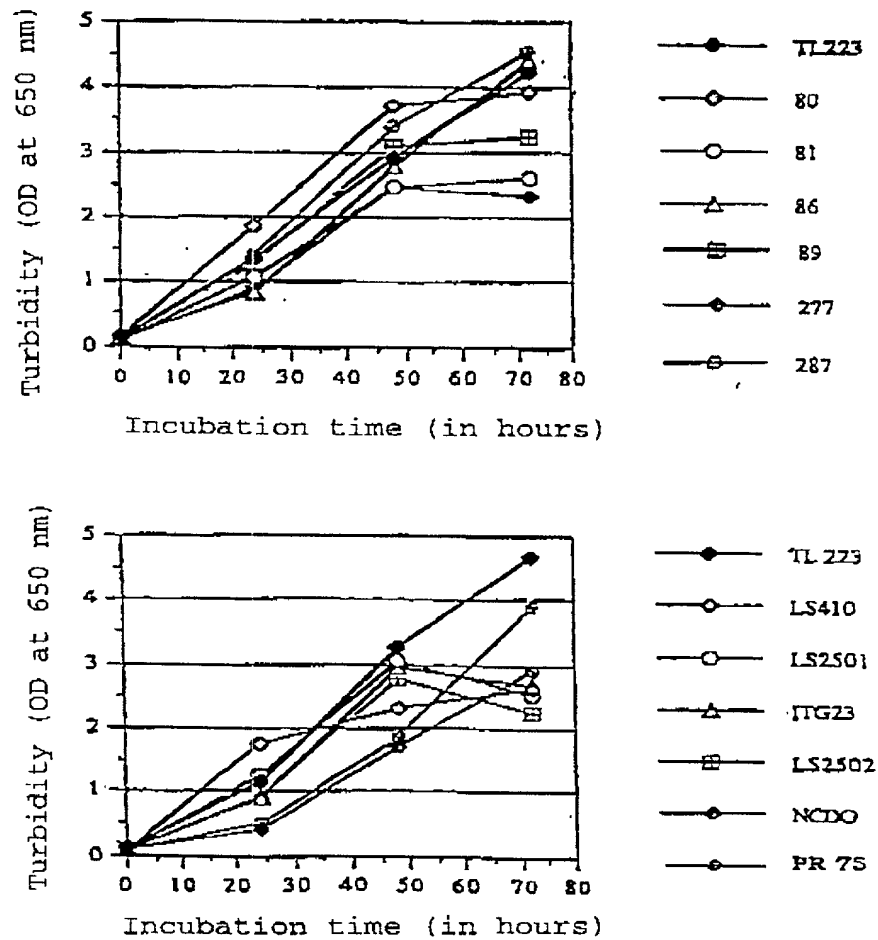


Figure 12



12/12

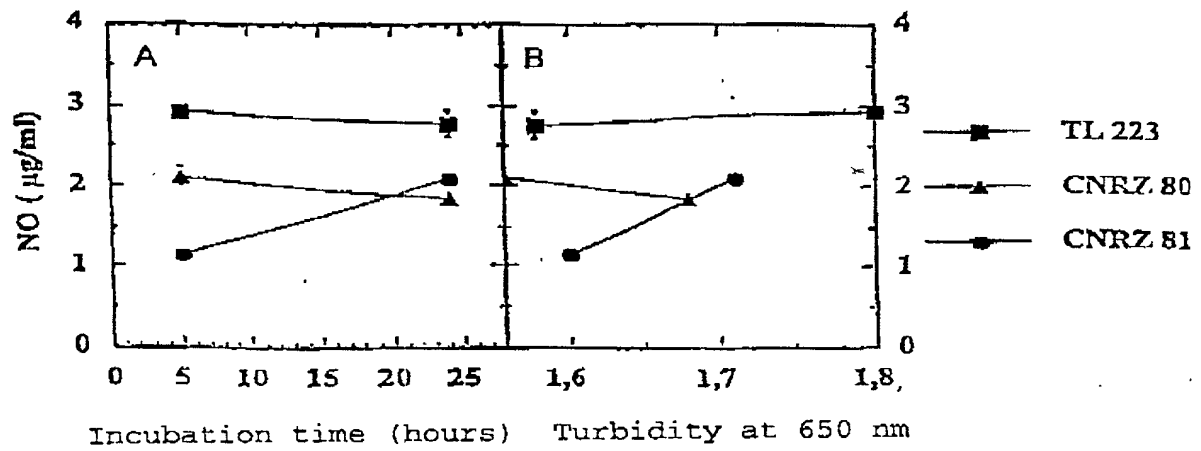


Figure 16

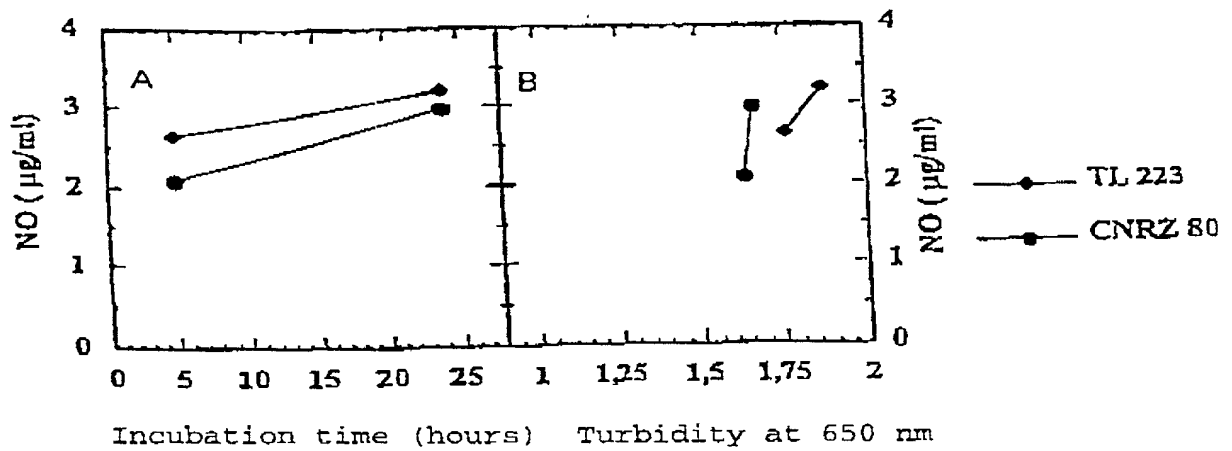


Figure 17

# Declaration and Power of Attorney For Patent Application

## Declaration Pour Demandes de Brevets Avec Pouvoirs

### French Language Declaration

En tant qu' inventeur nommé ci-après, Je déclare par le présent acte que:

Mon nom, mon domicile, mon adresse postale, ma nationalité sont ceux qui figurent ci-après,

Je déclare que je crois être l'inventeur original, premier et unique (si un seul nom figure sur le présent acte) ou un des co-inventeurs, originaux et premiers (si plusieurs noms figurent sur le présent acte) du sujet revendiqué et pour lequel un brevet est demandé sur la base de l'invention intitulée:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

dont la description  
(cocher la case correspondante)

☐ est annexée au présent acte.

☐ a été déposée \_\_\_\_\_

Numéro de série de la demande \_\_\_\_\_

et modifiée le \_\_\_\_\_  
(si approprié)

Je déclare par le présent acte avoir examiné et compris le contenu de la description identifiée ci-dessus, revendications y compris, et le cas échéant telle que modifiée par l'amendement cité plus haut.

Je reconnais le devoir de divulguer l'information qui est en rapport avec l'examen de cette demande selon Titre 37 du Code des Règlements Fédéraux §1.56(a).

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

ABSORBABLE COMPOSITION CONTAINING  
PROPIONIC BACTERIA CAPABLE OF RELEASING  
NITRIC OXIDE IN THE HUMAN OR ANIMAL  
ALIMENTARY CANAL

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on June 21, 1999 as

Application Serial No. 09/331,554

and was amended on \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

## French Language Declaration

Je revendique par le présent acte le bénéfice de priorité étrangère selon Titre 35, du Code des Etats-Unis, §119 de toute demande de brevet ou d'attestation d'inventeur énumérée ci-après, et j'ai identifié également ci-après toute demande étrangère de brevet ou d'attestation d'inventeur ayant une date de dépôt antérieure à celle de la demande pour laquelle la priorité est revendiquée.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior foreign applications

Demande(s) de brevet antérieure(s) dans un autre pays:

96/15977	France	24 December 1996		
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Année de dépôt)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
			Yes Oui	No Non
97/00885	France	28 January 1997		
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Année de dépôt)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
			Yes Oui	No Non
PCT/FR97/02399	PCT	23 December 1997		
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Année de dépôt)	<input checked="" type="checkbox"/>	<input type="checkbox"/>
			Yes Oui	No Non

Priority claimed

Droit de priorité  
revendiqué

Je revendique par le présent acte, le bénéfice selon Titre 35 du Code des Etats-Unis, §120 de toute(s) demande(s) américaines énumérée(s) ci-après et, dans la mesure où le sujet de chacune des revendications de cette demande n'est pas divulgué dans la demande américaine antérieure, de la façon définie par le premier paragraphe de Titre 35 du Code des Etats-Unis, §112, je reconnais le devoir de divulguer l'information pertinente selon Titre 37 du Code des Règlements Fédéraux, §1.56(a), toute information qui se présente entre la date de dépôt de la demande antérieure et la date de dépôt de la demande, soit nationale, soit internationale PCT.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.) (No. de Demande)	(Filing Date) (Date de Dépôt)
(Application Serial No.) (No. de Demande)	(Filing Date) (Date de Dépôt)

(Etat) (brevetée, pendante, abandonné)	(Status) (patented, pending, abandoned)
(Etat) (brevetée, pendante, abandonnée)	(Status) (patented, pending, abandoned)

Je déclare par le présent acte que toutes mes déclarations, à ma connaissance, sont vraies et que toutes les déclarations faites à partir de renseignements ou de suppositions, sont tenues pour être vraies; de plus, toutes ces déclarations ont été faites en sachant que de fausses déclarations volontaires u autres actes de même nature sont sanctionnées par une amende ou un emprisonnement, ou les deux, selon la Section 1001, du Titre 18 de Code des Etats-Unis et que de telles déclarations délibérément fausses peuvent compromettre la validité de la demande ou du brevet délivré.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## French Language Declaration

POUVOIR: En tant qu'inventeur, je désigne l'(les) avocat(s) et/ou l'(les) agent(s) suivant(s) pour poursuivre la procédure de cette demande et traiter toute affaire la concernant supris du Bureau des Brevets et de Marques: .

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

John F. Hoffman, Regis. No. ~~26,280~~; Anthony Niewyk, Regis. No. ~~24,871~~; Kevin R. Erdman, Regis. No. ~~33,687~~; Brian C. Pauls, Regis. No. ~~40,122~~; Michael D. Smith, Regis. No. ~~40,181~~; Kevin T. Duncan, Regis. No. ~~41,495~~; Arthur R. Whale, Regis. No. ~~18,778~~; Lawrence A. Steward, Regis. No. ~~32,309~~; Edward J. Prein, Regis. No. ~~37,212~~; James D. Hall, Regis. No. ~~24,893~~ and Ken C. Decker, Regis. No. ~~25,422~~; of BAKER & DANIELS

Adresser toute correspondance à:

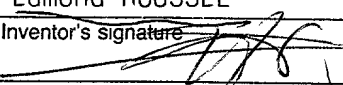

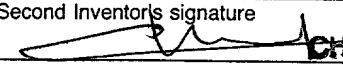

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Charles LEGRAND		Charles LEGRAND	
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Domicile		Residence	
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(Fournir les mêmes renseignements et la signature de tout co-inventeur supplémentaire.)

(Supply similar information and signature for third and subsequent joint inventors.)

[illegible]

(GIVEN NAME)

(MIDDLE INITIAL OR NAME)

(FAMILY OR LAST NAME)

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20.07.1999

France

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(GIVEN NAME)

(MIDDLE INITIAL OR NAME)

(FAMILY OR LAST NAME)

**Date:**

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